CAFTA-DR
Environmental Cooperation Program

Oceans and International
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U.S. DEPARTMENT of STATE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

BATTELLE

LANDFILL CONSTRUCTION AND OPERATIONS WORKSHOP

LANDFILL CONSTRUCTION AND OPERATIONS WORKSHOP

No.	Module	Presenter
1	Importance of Proper Landfill Management	P. Ruesch
2	Landfill Construction Part I	M. Elizondo
3	Landfill Construction Part II	J. Davila
4	Landfill Operations Part I	M. Elizondo
5	Landfill Operations Part II	M. Elizondo
6	LFG Basics and GCCS	J. Davila
7	LFG Utilization Technologies	J. Davila
8	Open Dump Closure	P. Ruesch

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Module No. 7
LFG Utilization Technologies

Jose Luis Davila
Independent Consultant

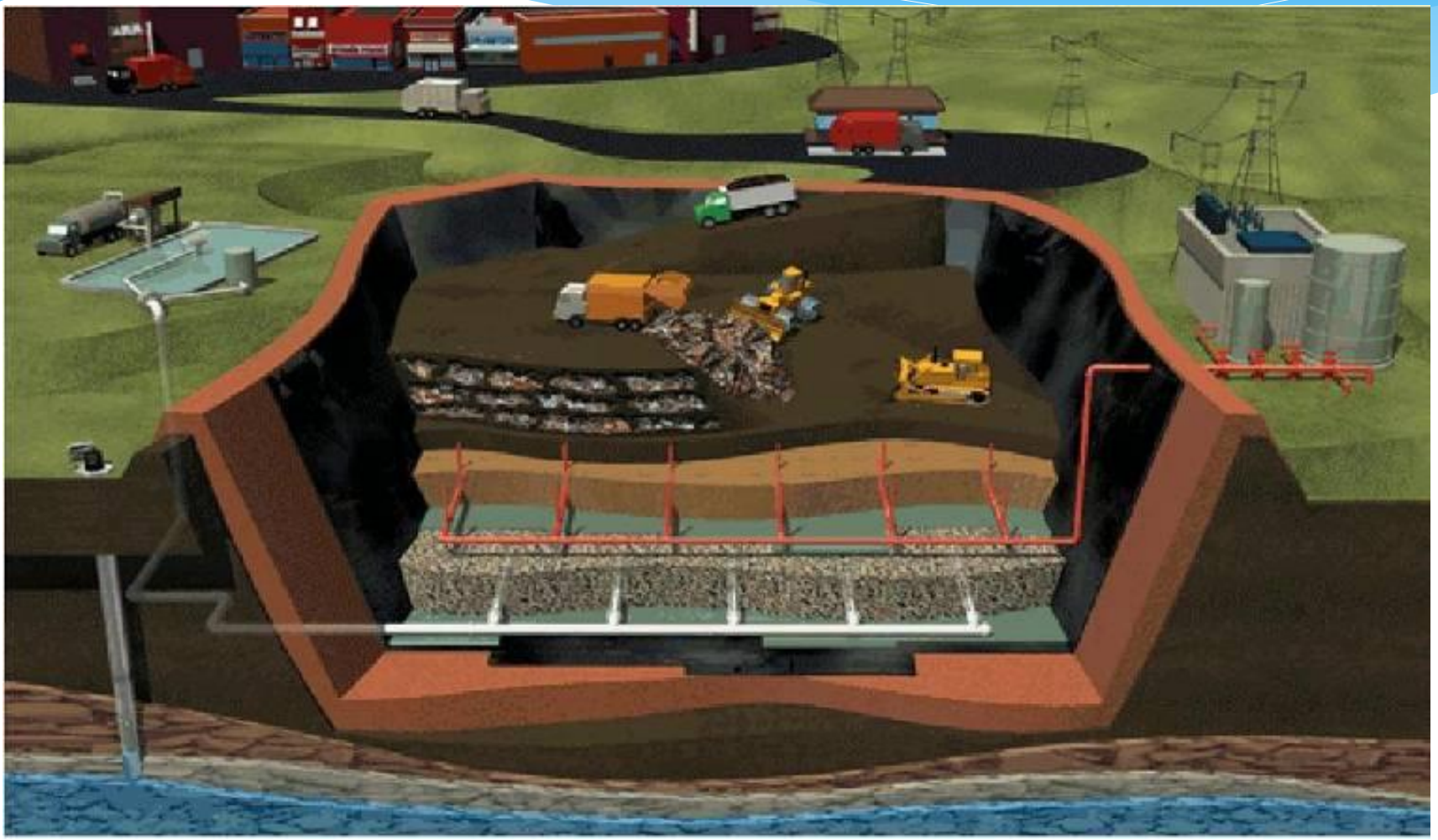
Content

- General aspects
- Direct use – medium heat content
- Direct use – High heat content
- Power generation
- Combine heat and power (cogeneration)

Why use LFG ?

- Local fuel source
- Recovery & use relatively simple
- Source of renewable energy
- Available 24 hrs/day, 7 days/week
- Proven utilization technologies
- 'Use of lose' resource
- Greenhouse gas (GHG) emission reductions

Landfill Concept



Benefits

- Destroys Methane and other NMOCs in LFG
- Replaces use of non-renewable sources
- Landfill owner benefits:
  - New revenue source
  - Local economic development by creating new jobs
- End user benefits:
  - Reduced fuel cost
  - Use of renewable sources
  - Support “green/sustainable” image

Benefits

Each MW generated uses approximately 615 m^3/h of LFG, with annual benefits of:

- Planting 4900 ha of trees; or
- Reducing CO_2 emissions from 9000 vehicles; or
- Preventing use of 99,000 barrels of oil; or
- Preventing use of 200 train cars of coal; or
- Providing electricity to ~ 650 homes

How is LFG Used?

- Tomatoes & flowers
- Ceramic & glass
- Vehicles
- Pharmaceuticals
- Bricks & cement
- Metals
- Orange & apple juice
- Biodiesel, LNG & ethanol
- Fiberglass & paper
- Jeans
- Electronics
- Chemicals
- Chocolate
- Sanitary sludge dehydration
- Soy products
- Carpets
- Infrared heating
- Green energy
- Cost savings
- Increase sustainability

Utilization Options

- Medium heat content
  - Direct use or with minimal treatment for commercial, institutional or industrial use to supply heaters, ovens, dryers, incinerators, etc. Typically with a 50% CH_4 content
  - Leachate evaporation
    - LFG used as a fuel to evaporate leachate & reduce treatment costs
- High heat content
  - LFG is purified to levels of 92 - 99% CH_4, removing CO_2. End use as natural gas or compressed natural gas
- Electricity
  - LFG is used as a fuel in internal combustion engines or turbines to generate power to send to local network

Project Structure

Landfill

Utilization Technology

"Pipeline"

End-User

Medium BTU

- Less investment, less energy

High BTU

- More investment
- LFG needs to be purified to ~95% CH_4 to sell to gas company

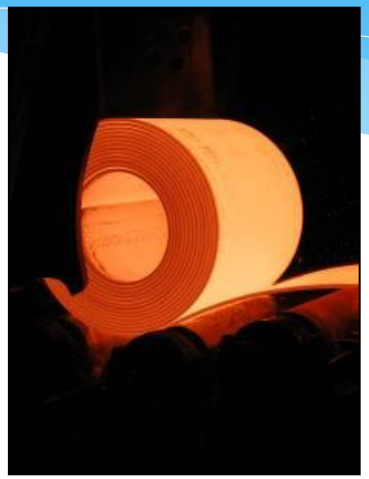
Power Generation

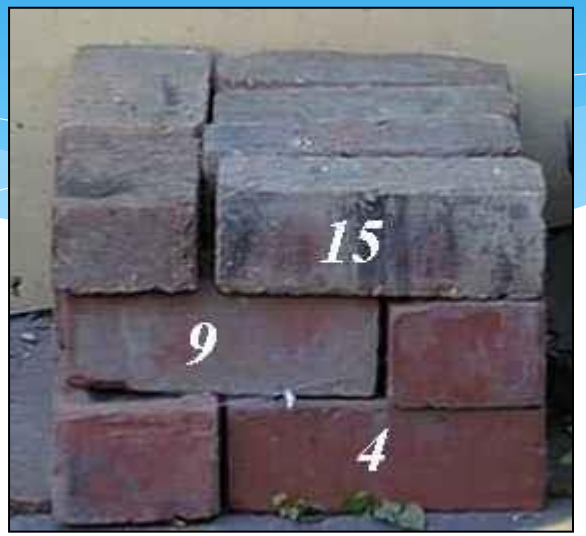
- Requires interconnection to local network
- Feasibility depends on kWh value long term

Who is using LFG?

Direct Use

- **Boilers**
- **Direct thermal applications**
  - Ovens
  - Heaters
- **Innovative applications**
  - Greenhouses
  - Infrared heaters
  - Ceramic ovens
  - Leachate evaporation





Direct Use

- Over 100 projects in USA
- Pipeline length varies 0.6 - 15 km
  - < 10 km is feasible
- LFG is used by end-user off landfill property
- LFG is transported via dedicated pipeline to end-user

Direct Use

- In most cases = most viable option
- End-user could be located up to 10km, though depends on complexity of pipeline
- Typically sold with a discount from typical natural gas prices
- Key Point – This type of project is not difficult if regulatory agencies require pipeline to meet typical natural gas standards

Three Rivers Solid Waste Authority

Kimberly Clark/Siemens - Aiken, South Carolina

Compression and dehydration plant

- Developed by SIEMENS
- Started: April 2008
- LFG Flow: 3,390 M^3/h.
- Pipeline: 25.4 km
- Compression 40 lb/in^2
- LFG is use in boilers at Kimberly Clark facility

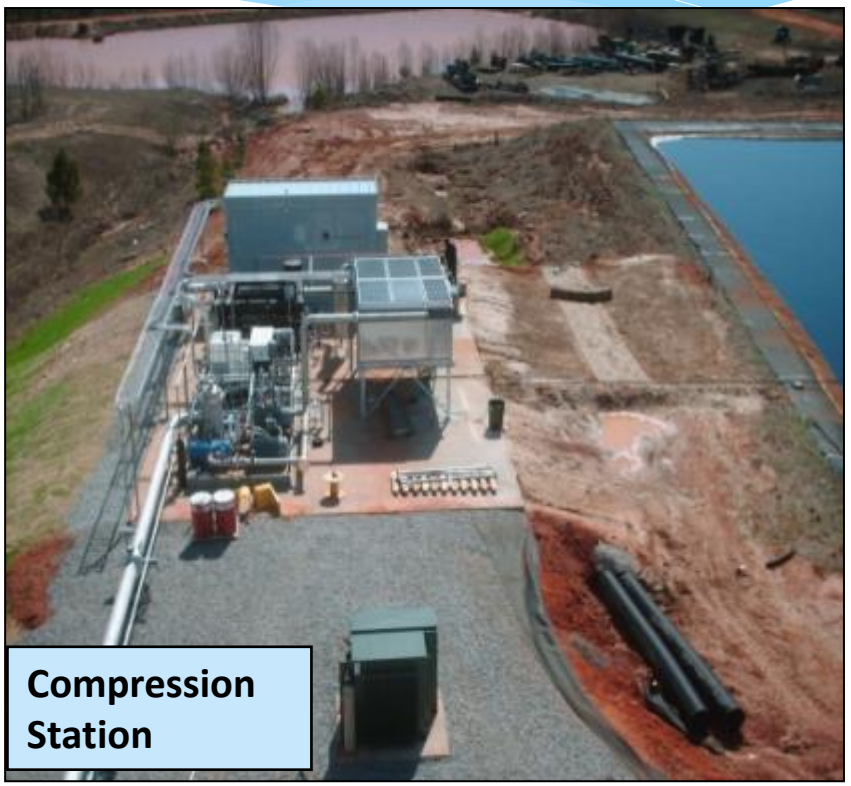
Capital Costs

- ~$2.0 Million

Schedule

- 8 months for design and installation

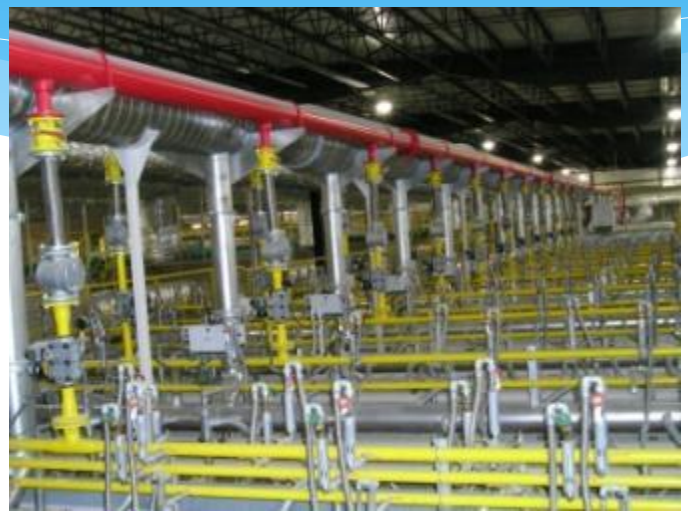
https://trswa.org/landfillgas.shtml

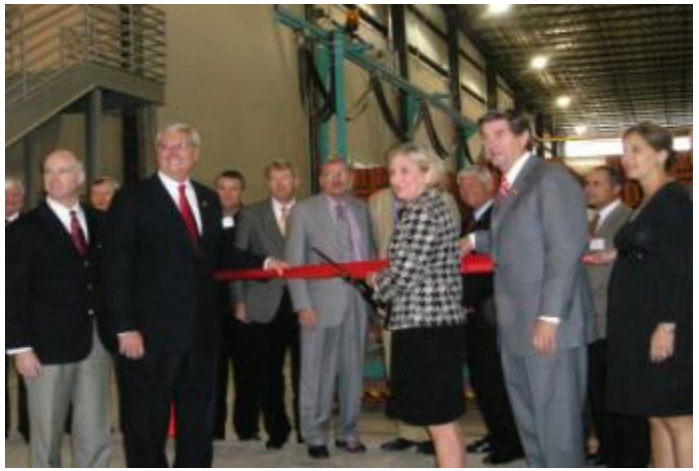


Compression Station

Jenkins Brick Factory
Moody, Alabama

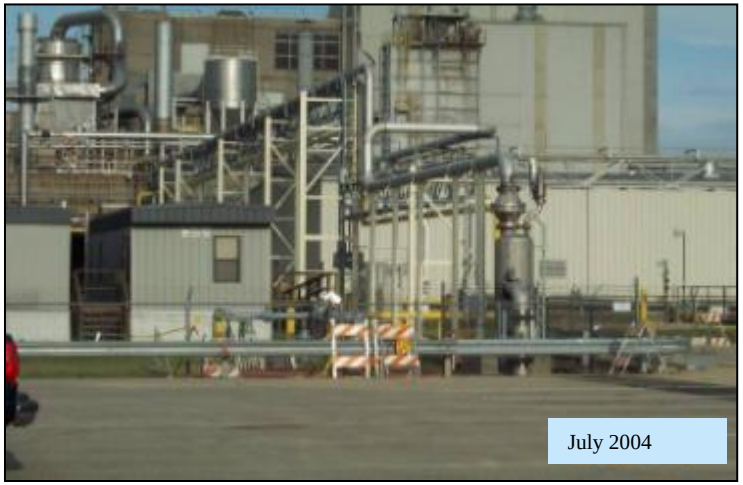
- Factory located near landfill
- Pipeline: 11 km
- Start: 2006
- LFG Flow: 1,015 m^3/h (=18 MMBtu/h)
- Used in oven
- LFG ~ 45% of total energy needs
- Benefits
  - Savings of $600,000 in 7 yrs
  - Good public relations
  - Local economic development





SOLAE - South Shelby Landfill
Memphis, Tennessee

- Largest renewable project in state
- LFG flow = 8,475 m^3/h
- Constructed in 150 days
- Modified combustion system and integrated automation systems to optimize use of LFG
- Design and construction of flares and automation systems
- Reduction of more than 65% on NG emissions
- Pipeline: ~8 km
- Reduction of NOx emissions by 75%



Cranberry Creek Landfill
Ocean Spray Corporation, Wisconsin

- Design and systems integration to supply LFG to new boilers
- Control systems design to operate automatically
- Optimization to use fuel with less operational cost
- Monitoring and diagnostic systems operated remotely

- https://www.advanceddisposal.com/wi/wisconsin-rapids/cranberry-creek-landfill

Greenhouses

- LFG use as power and heat source
- CO_2 can be used to improve plant growth
- ~ 6 projects in USA

Leachate Evaporation

- LFG is used to treat leachate
- Available technology
- ~ 20 projects operating in USA & internationally

High Heat Content

- **Technology**
  - LFG is purified from 50% to 97%- 99% CH_4
  - Removal of CO_2
- **Advantages**
  - Injection to pipeline
  - Treated gas can be used as a natural gas equivalent
  - Reduced use of fossil fuels
- **Disadvantages**
  - Must meet strict standards for pipelines
  - Technology is costly
  - Economically viable at large scale

High Heat Content

Montauk Energy - Valley & Monroeville, Pennsylvania

- Started operations in 2006
- LFG to high BTU, gas pipeline quality
  - Membrane technology
- Supply:
  - Low pressure pipeline for local distribution
  - High pressure transmission pipeline
- http://montaukenergy.com/operations/monroeville/

Photos courtesy of Montauk Energy

Vehicular Fuel

- Compressed Natural Gas (CNG)
- Heavy waste collection equipment
- Buses and other public transpiration
- Can be used to convert to methanol to biodiesel
- Production of ethanol

Power Generation

- **Most common utilization project in USA**
  - Close to 1100 MW capacity in > 250 projects
- **Sale of electricity to:**
  - Local network
  - Cooperatives or industry qualified for direct purchase
  - Large consumers nearby
  - Self-generation
- **Average size ~** 4 MW (500 kW - 50 MW)

Power Generation

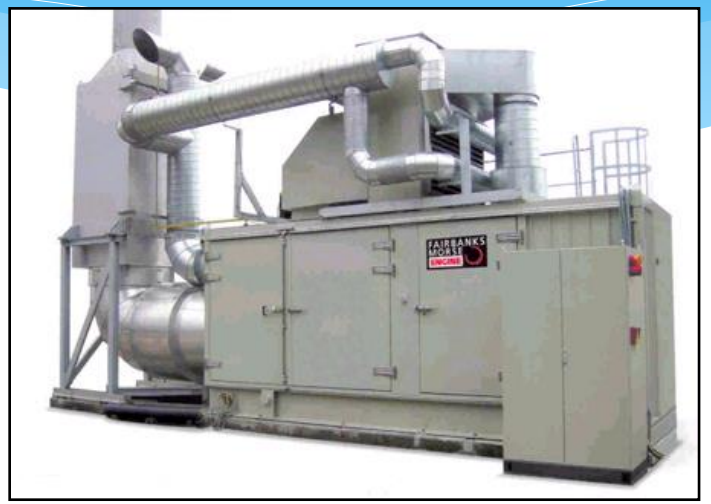
- Internal combustion engines
- Turbines
- Microturbines
- New technologies
  - Fuel cells

Internal Combustion Engines

- Capacity: 350 kW- 3 MW
- Advantages
  - Proven & reliable
  - Efficient
  - High availability >92%
  - Does not require treatment
- Disadvantages
  - High O&M cost
  - High NOx & CO emissions

Turbines: LFG, Vapor & Combined Cycle

- Capacity: 1 - 6 MW
- Advantages
  - High resistance to corrosion
  - Lower O&M cost
  - Small physical size
  - Low NOx emissions
- Disadvantages
  - Inefficient in partial load
  - High parasitic loads due to high compression requirements
  - Requires pre-treatment



Microturbines

- Capacity: 30-200 kW
- Advantages
  - Low emissions
  - Typically use for self-generation
  - Multiple fuel capacity
  - Small
  - Low O&M costs
- Disadvantages
  - Inefficient
  - High capital cost ($/kW) installed

Combined Heat and Power

- **Large industry**
- **Application in turbines and microturbines**

Combined Heat and Power

- **Advantages**
- Better energy recovery efficiency through the residual heat recovery – up to 80%
  - Specialized systems available
  - Flexible – hot water or vapor generation through heat recovery
- **Disadvantages**
  - Higher capital cost

Internal Combustion Engines and Greenhouse
Model City, New York

- Developed by Innovative Energy Systems (IES)
- Start: June 2001
- Capacity: 5.6 MW with 7 engines (Caterpillar G3516)
- Supplies all power & heat needs to greenhouses
- Excess power sold to local networks
- 7½ acres produce 10,000 lb/day or 3.5 million lbs/yr
- https://www.power-eng.com/2005/06/01/innovative-energy-systems-landfill-l-gas-plants/#gref

Combined Heat & Energy - BMW South Carolina

- Pipeline = 15 km
- 4 turbines reconditioned to use LFG
- 4.8 MW = 25% of plant needs
- 72 MMBtu/hr = 80% thermal needs (hot water, heat, and cooling)
- Savings ~ $1m/yr

- http://www.epa.gov/lmop/proj/profile/bmwmanufacturinglandfillg.htm

Combined Heat and Power
Antioch Community High School,
Antioch, Illinois

- First LFG co-generation project in a school
- 12 microturbines with 360 kW capacity
- Residual heat produced is 306,000 kJ/hr, used to heat water
- Savings ~ $100,000/yr

https://www.mswmanagement.com/collection/article/13001973/landfill-gastoenergy-solving-problems

Thank You

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